HISTOLOGICAL FEATURES CORRELATED WITH GAS SECRETION IN *HYDRA OLIGACTIS* PALLAS.

WM. A. KEPNER AND W. L. THOMAS, JR.,

UNIVERSITY OF VIRGINIA.

The ectoderm of the basal disc of hydra ordinarily elaborates mucus by means of which the polyp adheres to some submerged surface. It has recently been observed that this same ectoderm may, under certain circumstances, elaborate gas. This gas is held within a sack of mucus (Kepner and Miller, '28). This fact has suggested to us that there may be some interesting histological change correlated with the elaboration of gas. Kepner and Miller have found, to begin with, that there is a peculiar region in hydra's endoderm in the basal disc. This endoderm supplies the food demanded by the metabolism that yields the two products of the basal disc's ectoderm—mucus and gas.

Their observation concerning this local accumulation of food was interesting; for it carried the point, arising out of Tannreuther's ('09) observation, a step further. Tannreuther's observation was that in the region of a developing gonad or of an incipient bud there were local and pronounced accumulations of food within the endoderm. Yoder ('26) found that there was a marked accumulation of glycogen in these regions of most active metabolism. Finally Kepner and Hopkins ('24) observed that there was not a wide diffusion of material absorbed by the endoderm. For example, they recorded that "there is no extensive diffusion of absorbed chloretone through the tissues of the body. A diploblastic animal, therefore, cannot possess anything comparable to a circulatory medium" (p. 448). Our observations further strengthen the hypothesis that local needs must be met locally.

The detailed histology of the basal third of a hydra, that had not been secreting gas, shows the lateral endodermal cells to be stout and highly vacuolated (Fig. 1, *c*). The extent of distribution of these lateral cells varies greatly in different specimens and

perhaps also in the same specimen at different phases of the polyp's activity. The cells of the endoderm of the basal disc are more slender and present a denser cytoplasm than do the cells of the above lateral endoderm. They also carry within their cytoplasm food vacuoles (Fig. 1, *f*). Food-vacuoles are not present in the lateral endoderm of the basal part of hydra. The lateral ectoderm of the basal third does not in any manner differ from that of the general ectoderm of the body. The ectoderm of the basal disc, however, presents features that are peculiar to it. In the first place, there are no nematocysts in this region, of the outer epithelium. These cells, moreover, when actively discharging mucus have conspicuous inclusions within their cytoplasmic bodies. These may be designated secretion-granules (Fig. 1, *m g*). These

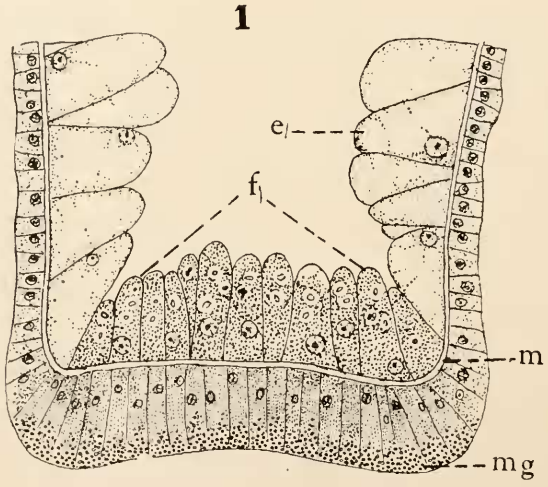

FIG. 1. Partly diagrammatic, axial section of base of hydra that had been elaborating mucus in order to fix itself to substratum. *e*, lateral endoderm of basal third of body; *f*, peculiar endoderm that lines the fundus of the enteron and contains food-vacuoles; *m*, mesoglea; *mg*, mucus-granules arising within the mucus-secreting cells of ectoderm. × 650.

cells extend over the entire basal disc. All attached hydras will not show the secretion-granules in the ectodermal cells throughout the extent of the basal disc. A specimen that has long been attached to the substratum may not yield, when fixed and stained, sections that display secretion-granules. Only specimens caught at the time they are fixing themselves to a substratum will present

these secretion-granules in sections (Fig. 1, *m g*). The most emphasis must here be placed upon the condition of the mesoglea. In a mucus-secreting specimen, the mesoglea of the basal disc differs in no manner from that of the body proper. It presents a uniform, unbroken contour (Fig. 1, *m*). All this in no manner presents anything new concerning the histology of hydra.

In the gas-secreting hydra some conspicuous histological features appear that have not been recorded. In the first place, the endodermal cells of the basal disc appear to be larger and more active in the gas-secreting specimens than in the non-secreting ones. Next we find that the ectodermal cells of a wide peripheral region of the disc elaborate mucus. These, in other words, do not have their usual function changed. The axial cells in the basal disc's ectoderm, however, do have their function altered. They no longer present secretion-granules and therefore stain (in hæmatoxylin) less than do the peripheral cells of the disc. We have now an epithelium the periphery of which elaborates a retaining wall of mucus, while the axial region secretes gas into the mucus to form a buoy or lifting float for the polyp (Fig. 2, *mc* and *gc*). The most conspicuous feature of the gas-secreting polyp lies in the mesoglea's modification. The mesoglea, in this disc at this time, becomes greatly swollen and highly vacuolated as though the endoderm had flooded it with a deposit of metabolic substance. Within this broken region of the mesoglea there appears, in fixed material, a substance that suggests a coagulated plasma (Fig. 2, *m'*). The presence of this plasma within the mesoglea may signify one of two things: (1) It may be that food is being deposited there by the endoderm in order to meet the demands of an intense metabolism taking place during gas-elaboration, or (2) It may be that metabolic substances are being dammed back from the relatively active axial ectoderm while it is elaborating gas. If the first alternative be correct, a plasma, as it were, is thrown down locally into the axial mesoglea of the basal disc in order that the gas-secreting cells may be abundantly supplied with food during the peculiar metabolism involved. If the second alternative be correct, it means that the axial ectoderm is throwing metabolic wastes into the mesoglea. Ordinarily the ectoderm discharges its metabolic wastes externally through a moist mucus when the

polyp is fixed, or directly into the water when the polyp lies free. When, however, a layer of gas is deposited upon the outside of this basal, axial ectoderm the osmotic drainage is blocked. The presence of the gas no longer lets the metabolic wastes drain by means of an osmotic exchange through the free ends of the axial, ectodermal cells. Hence metabolic wastes, instead of metabolic food, back into the mesoglea to flood it and form the vesicle that we have observed. As the elaboration of gas advances the vesicle of the mesoglea, together with its included plasma, decreases until, at the time of the gas-buoy's attaining its maximum size, the mesoglea has returned to the condition characteristic of the general mesoglea.

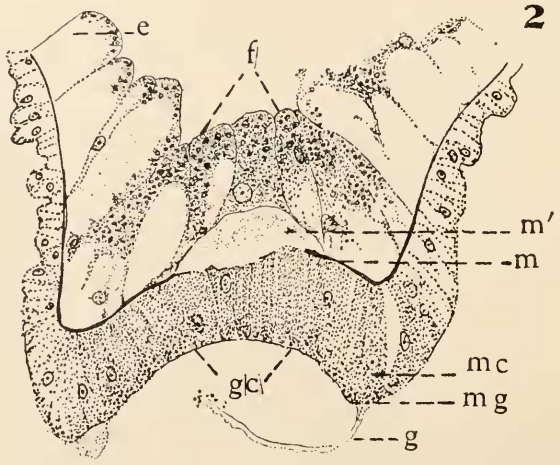

FIG. 2. Axial section of base of hydra that had been elaborating a gas-bubble. *e*, lateral endoderm of basal third of body; *f*, peculiar endoderm that lines fundus of enteron and contains food-vacuoles; *gc*, gas-secreting region of ectoderm; *mg*, mucus-granules; *g*, mucus wall of gas-bubble; *mc*, mucus-secreting region of ectoderm; *m* unbroken, but deeply staining region of mesoglea; *m′*, plasma-like material within distended region of basal mesoglea. × 650.

It matters not which of the above alternatives be the correct interpretation, the interesting point may be made that, in the basal disc of hydra secreting gas, we have a situation arising that makes a peculiar demand upon the passive mesoglea. As a result, the mesoglea is sometimes flooded either with metabolic food or with metabolic wastes. Thus we have the mesoglea foreshadowing the

function of a true circulatory medium such as is found in the plasma of the Turbellaria or even in that of the blood and lymph of the higher triploblastic animals.

Summary.

The basal disc of hydra has a two-fold secretory function: (1) It secretes a mucus by means of which the polyp is anchored. (2) It secretes gas that is retained within a wall of mucus by means of which the polyp is lifted to the surface of the water. This dual function of the basal disc places a peculiar metabolic demand upon the disc's endoderm, ectoderm and mesoglea. As a result of this peculiar metabolism and the conditions arising out of gas-secretion, the mesoglea becomes flooded with a plasma and thus handles either metabolic food or metabolic wastes in a manner that foreshadows the plasma of the circulatory media of triploblastic animals.

LITERATURE.

Kepner, Wm. A., and D. L. Hopkins.
'24 Reactions of *Hydra* to Chloretone. J. Exp. Zoöl., Vol. 38.
Kepner, Wm. A., and Lulu Miller.
'28 A New Histological Region in *Hydra*. Biol. Bull. Present Vol.
Tannreuther, Geo. W.
'09 Budding in Hydra. Biol. Bull., Vol. 16.
Yoder, M. C.
'26 The Occurrence, Storage, and Distribution of Glycogen in *Hydra viridis* and *Hydra fusca*. J. Exp. Zoöl., Vol. 44.